Q: What is Lean Manufacturing ?

A: Lean manufacturing is a production process based on an ideology of maximizing productivity while simultaneously minimizing waste within a manufacturing operation. The lean principle sees waste as anything that doesn't add value that the customers are willing to pay for.

Q: What are the Principles of Lean Manufacturing ?

A: According to Womack and Jones, there are five key lean principles: value, value stream, flow, pull, and perfection.

1. **Value:** Value is always defined by the customer's needs for a specific product. For example:

- What is the timeline for manufacturing and delivery?
- What is the price point?
- What are other important requirements or expectations that must be met?

This information is vital for defining value.

2. **Value stream:** Once the value (end goal) has been determined, the next step is mapping the "value stream." This includes all the steps and processes involved in taking a specific product from raw materials and delivering the final product to the customer.

   Value-stream mapping is a simple but eye-opening experience that identifies all the actions that take a product or service through any process—design, production, procurement, HR, administration, delivery, or customer service. The idea is to draw a "map" of the flow of material/product through the process, with a goal of identifying every step that does not create value and then finding ways to eliminate those wasteful steps.

   Value-stream mapping is sometimes referred to as process re-engineering. Ultimately, this exercise also results in a better understanding of the entire business operation.

3. **Flow:** After the waste has been removed from the value stream, the next step is to be sure the remaining steps flow smoothly with no interruptions, delays, or bottlenecks. In the words of LEI: "Make the value-creating steps occur in tight sequence so that the product or service will flow smoothly toward the customer."

   This may require breaking down silo thinking and making the effort to become cross-functional across all departments, which can be one of the greatest challenges for lean programs to overcome.

However, studies show that this will also lead to huge gains in productivity and efficiency—sometimes as high as 50% improvement or more.

4. **Pull:** With improved flow, time to market (or time to customer) can be dramatically improved. This makes it much easier to deliver products as needed, as it means the customer can "pull" the product from you as needed (often in weeks, instead of months).

   As a result, products don't need to be built in advance or materials stockpiled. This reduces the need for an expensive inventory that needs to be managed, saving money for both the manufacturer/provider and the customer.

5. **Perfection:** Accomplishing steps 1-4 is a great start, but the fifth step is perhaps the most important: making lean thinking and process improvement part of your corporate culture. Every employee should be involved in implementing lean.

   As gains continue to pile up, it is important to remember that lean is not a static system and requires constant effort and vigilance to perfect. Lean experts often say that a process is not truly lean until it has been through value-stream mapping at least half a dozen times.

Advantages of Lean Manufacturing

1. **Waste Minimization:**

Lean manufacturing can efficiently minimize waste within a production facility. This is arguably the most significant benefit of lean manufacturing. Waste is defined by any activity that does not add value to the process. Common waste areas include: motion, inventory, waiting, overproduction, defects, transportation, and over-processing. As companies sit on large amounts of inventory and waste, this process eliminates outdated or aged inventory. In addition, this process reduces the costs within the operation.

2. **Enhanced Customer Relationships:**

Lean focuses on loyal customers' concerns and suggestions to cut some wasteful processes. Rather than focusing on the needs of all customers, companies are able to focus on their loyal customers to build strong and reliable relationship. This way, your customer interactions will improve and the relationships with your trusted customers will offer a steady flow of revenue coming in.

3. **Lean Infrastructure:**

A lean infrastructure means that you are only dealing with a few components: building, tools, supplies, equipment, and labor to fulfill near-term inventory demand. The facility does not waste space within the operation and enables the facility to come as close as it can to production efficiency.

Disadvantages of Lean Manufacturing

1. **Equipment Failure:**

Lean has very little room for error. Equipment or labor failure can lead to major inconsistencies and can make the entire operation fall behind. In other mass production facilities, employees could move from one machine to another in the event of a breakdown. In lean, there are not many other places for employees to move to because everything within the operation is being utilized. In addition, the breakdown of a machine must be fixed immediately as there are usually no alternative resources that can do the work. This is why it is important to stay on top of all machine maintenance and inspections.

2. **Delivery Inconsistencies:**

In correlation with equipment failure, lean manufacturing can lead to delivery inconsistencies. Using lean techniques means that you have a smaller error margin. If your supply deliveries are late, you may not have enough raw materials to meet your customer demands, leading to late deliveries. This disadvantage can hinder customer relationships, push customers towards your competitors, and cost you revenue.

3. **Employee Dissatisfaction:**

Adopting lean manufacturing processes requires change among employees to more efficient production processes to ensure that quality products are being made. This can be risky if employees reject the new methods. Having good managers that can help support and persuade the change from one technique to another can be helpful.

Q: What is AGV ?

A: Sometimes called self-guided vehicles or autonomous guided vehicles, automated guided vehicles (AGVs) are material handling systems or load carriers that travel autonomously throughout a warehouse, distribution center, or manufacturing facility, without an onboard operator or driver.

Applications for AGVs

Automated guided vehicle systems are used for tasks that would typically be handled by forklifts, conveyor systems or manual carts, moving large volumes of material in a repetitive manner.

AGVs are used in a variety of applications. They’re often used for transporting raw materials such as metal, plastic, rubber or paper. For example, AGVs can transport raw materials from receiving to the warehouse or deliver materials directly to production lines. AGVs consistently and reliably deliver raw materials needed without human intervention, ensuring that production lines always have the materials they need without interruption.

In addition to transporting raw materials, AGVs are used in work-in-process applications and with finished goods to support production or manufacturing lines. The term work-in-process describes “partially completed goods, which are typically turned from raw material to finished product in a short period of time,” such as manufactured goods. In work-in-process applications, AGVs move materials or parts from the warehouse to production lines or from one workstation to another, providing repetitive and efficient movement of materials throughout the manufacturing process. Without AGVs, manufacturing processes may come to a halt when processing lines run out of materials. Manufacturing is then delayed while a human worker retrieves the necessary materials from storage and transports them to the production line.

AGVs are also used in inbound and outbound handling for replenishment and for picking. For example, AGVs may be used to transport inventory from receiving to storage locations or from long-term storage locations to forward picking locations to replenish stock. Moving inventory from long-term storage to forward picking locations ensures that adequate inventory is accessible to pickers, making the order picking process more efficient. AGVs such as collaborative mobile robots assist in the picking process by guiding warehouse associates through tasks and transporting picked orders to packaging and shipping workstations.

Types of Automated Guided Vehicles

There are several types of automated guided vehicles. Many AGVs are similar to other human-operated vehicles but are designed to operate without direct human intervention or guidance.

Automated Guided Carts

An automatic guided cart (AGC) is the most basic type of AGV with minimal features. Navigation systems can range from systems as simple as magnetic tape to complex, sensor-based navigation systems that use AI to navigate their environment. They can transport a variety of materials, from small parts to loaded pallets, and are often used in sorting, storage, and cross-docking applications.

One example of an AGC is an automated hospital cart transporter, used to efficiently transport compact loads throughout a hospital, such as meals and empty food trays, clean or soiled linens, biohazard waste or sterile supplies. Without the need for a staff member to manually push the cart from place to place, automated hospital cart transporters can help to reduce labor costs.

Forklift AGVs

Fork vehicles, or forklift automatic guided vehicles, are another commonly used type of AGV. They’re designed to perform the same functions a human-operated forklift performs (transporting pallets), but without the need for a human operator.

Towing AGVs

Towing vehicles, or tugger automatic guided vehicles, pull one or more non-powered, load-carrying vehicles behind them in a train-like formation. Sometimes called driverless trains, powered towing vehicles travel on wheels. Tugger automatic guided vehicles are often used for transporting heavy loads over longer

distances. They may have several drop-off and pick-up stops along a defined path through a warehouse or factory.

Unit Load Handlers

Unit load handlers carry discrete loads such as individual objects, or a single unit such as a pallet or tote that contains multiple items.

Heavy Burden Carriers

For the heaviest loads, heavy burden carriers are a type of AGV used in applications such as large assembly, casting and coil and plate transport. Some heavy burden carriers have self-loading capabilities and may have standard, pivot or omni-directional steering.

Autonomous Mobile Robots

Autonomous mobile robots (AMRs) are typically more technologically advanced than other types of AGVs. While many AGVs use fixed navigation systems, such as wires or magnetic tape, many AMRs are equipped with intelligent navigation capabilities such as sensors and camera systems that enable them to detect and navigate around obstacles. Thanks to more sophisticated technology, AMRs can dynamically navigate a warehouse or other facility and plan the most efficient paths.

How AGVs work

AGVs are self-propelled vehicles with movement guided by software and sensors. Most AGVs move along defined pathways, but as mentioned, AMRs typically have more advanced technology with dynamic navigation capabilities.

AGV navigation

AGV navigation may be guided using one or more of the following mechanisms:

- Magnetic guide tape — some AGVs have magnetic sensors and follow a track using magnetic tape.
- Wired navigation — some AGVs follow wire paths embedded into the facility floor. The wire transmits a signal that AGVs detect via an antenna or sensor.
- Laser target navigation — with this method, reflective tape is mounted on objects such as walls, fixed machines and poles. AGVs are equipped with a laser transmitter and receiver. The lasers reflect off of the tape within the line of sight and used to calculate the object's angle and distance from the AGV.
- Inertial (gyroscopic) navigation — some AGVs are controlled by a computer system with the aid of transponders embedded into the facility floor to verify that the AGV is on the proper course.
- Vision guidance — No modification is required to the infrastructure for vision-guided AGVs. Cameras record the features along the route, and AGVs rely on these recorded features to navigate.
- Geoguidance — Like vision-guided AGVs, no infrastructure modifications are required for AGVs that use geoguidance. Geoguided AGVs recognize objects in their environment to establish their location in real-time to navigate throughout the facility.

- LiDAR — LiDAR (Light Detection and Ranging) is a sophisticated navigation technology utilizing sensors that transmit laser pulses to measure the distance between the robot and objects in its environment. This data is compiled to create a 360-degree map of the environment, allowing robots to navigate the facility and avoid obstacles without the need for any additional infrastructure. 6 River Systems uses LiDAR navigation technology to enable their AGVs to navigate a warehouse without requiring changes to infrastructure as well as to adapt to new environments should the layout of a warehouse floor change.

AGV steering

AGV steering is controlled by differential speed control, steered wheel control or a combination of the two:

- Differential speed control — This is the most common type of steering control used by AGVs. Differential speed control uses two independent drive wheels. Each drive wheel is driven at a different speed to turn. To go forward or backwards, the two drives are driven at the same speed. The simplest steering control option for AGVs, differential speed control doesn't require additional steering motors or mechanisms. It is commonly used for AGVs that operate in tight spaces or for those that operate near machines. It is not used for towing applications, as it can cause a trailer to jackknife while turning.
- Steered wheel control — This type of steering control is similar to the steering control in a car or truck. In steered wheel control, the drive wheel is the turning wheel. Steered wheel control is more precise than differential speed control and offers smoother turning. It is often used for towing applications and may also be operator-controlled.
- Combination steering — This is a combination of differential speed control and steered wheel control. AGVs using combination steering have two independent steer/drive motors on diagonal corners of the AGV and swivelling castors on the other two corners. AGVs using combination steering can turn in any direction like a car and also drive in differential steering mode in any direction.

AGV traffic control

Traffic control measures include zone control, collision avoidance or a mix of both:

- Zone control — Simple to install and easy to expand, zone control is a commonly used traffic control method for AGVs. A wireless transmitter transmits signals in defined areas, and the AGV contains a sensor that receives the signal and transmits it back to the transmitter. If the area is clear, a "clear" signal is sent that allows the AGV to enter or pass through the area. If another AGV is in the area, a "stop" signal is sent that alerts other AGVs attempting to enter that the area is not clear. In this case, the waiting AGVs will stop and wait until the first AGV moves out of the zone and a "clear" signal is sent by the transmitter. Another way zone control can be used is by equipping each AGV with its own transmitter, allowing it to send a "do not enter" signal to other AGVs approaching the zone.
- Collision avoidance — AGVs using collision avoidance zone control are equipped with sensors that transmit a signal and wait for a reply to determine if an object is in front of it. These sensors may be sonic, which work like radar, or optical, which uses infrared sensors. Both work in a similar manner. Bumper sensors are

another type of collision avoidance sensor. Many AGVs are equipped with bumper sensors as a fail-safe. Bumper sensors stop to avoid a collision when they sense physical contact.
- Combination control — AGVs that use combination control are equipped with both collision control sensors and zone control sensors in order to offer more robust collision prevention in all situations. For instance, an AGV may use zone control as its primary traffic control system but also have collision avoidance sensors as a backup in case the zone control system malfunctions.

Benefits of AGVs

AGVs offer numerous benefits in warehousing and manufacturing.

Increase efficiency and productivity

Because they operate autonomously, AGVs increase efficiency and productivity, and they're predictable and reliable for repetitive tasks. AGVs eliminate unnecessary walking and also eliminate the physical labor of transporting materials. They set the pace for workers, as well, keeping associates on-task. AGVs like collaborative mobile robots guide associates through each task, reducing human error, which helps to improve order picking accuracy and minimize loss and misplaced products

Consistent costs

AGVs are typically acquired on a per unit or per rental period cost basis, so there's less fluctuation in costs compared to human labor, which can fluctuate based on market conditions and demand.

Flexibility

Some AGVs offer the flexibility of easily changing routes (compared to others which require re-routing guide wires or other infrastructure to adjust a vehicle's route). Automated guided vehicles are a scalable solution, as well, with the ability to add additional units based on demand.

Less space required

Compared to other automation solutions, such as conveyor systems, AGVs require less space. Some AGVs are smaller compared to traditional warehouse equipment, such as forklifts, which allows for floor layouts with narrower aisles and better space utilization.

Improved safety

Finally, AGVs are a safe automation solution for warehouses, distribution centers and manufacturing facilities. AGVs are equipped with sensors to avoid collisions. Advanced AGVs like AMRs have intelligent routing capabilities that enable them to plan the most efficient path through a warehouse or facility, reducing aisle congestion and preventing injuries.

What is Robots in Manufacturing ?

Some manufacturers use robotics to automate repetitive, menial tasks such as material handling and assembly. Industrial robots can typically complete these tasks faster and improve repeatability and quality. Common use cases of repetitive or fixed automation include: Material handling. Pick-and-place.

What is robotics in manufacturing example?

In robotic processing operations, the robot manipulates a tool to perform a process on the work part. Examples of such applications include **spot welding, continuous arc welding, and spray painting**. Spot welding of automobile bodies is one of the most common applications of industrial robots in the United States.

10 Historically Common Industrial Robot Applications

1. Arc Welding
Arc welding, or robot welding, became commonplace in the 1980s. One of the driving forces for switching to robot welding is improving the safety of workers from arc burn and inhaling hazardous fumes.

2. Spot Welding
Spot welding joins two contacting metal surfaces by directing a large current through the spot, which melts the metal and forms the weld delivered to the spot in a very short time (approximately ten milliseconds).

3. Materials Handling
Material handling robots are utilized to move, pack and select products. They also can automate functions involved in the transferring of parts from one piece of equipment to another. Direct labor costs are reduced and much of the tedious and hazardous activities traditionally performed by human labor are eliminated.

4. Machine Tending
Robotic automation for machine tending is the process of loading and unloading raw materials into machinery for processing and overseeing the machine while it does a job.

5. Painting
Robotic painting is used in automotive production and many other industries as it increases the quality and consistency of the product. Cost savings are also realized through less rework.

6. Picking, Packing and Palletizing
Most products are handled multiple times prior to final shipping. Robotic picking and packaging increases speed and accuracy along with lowering production costs.

7. Assembly
Robots routinely assemble products, eliminating tedious and tiresome tasks. Robots increase output and reduce operational costs.

8. Mechanical Cutting, Grinding, Deburring and Polishing
Building dexterity into robots provides a manufacturing option that is otherwise very difficult to automate. An example of this is the production of orthopedic implants, such as knee and hip joints. Buffing and polishing a hip joint by hand can normally take 45-90 minutes while a robot can perform the same function in just a few minutes.

9. Gluing, Adhesive Sealing and Spraying Materials
Sealer robots are built with numerous robotic arm configurations that enable the robot to apply adhesives to any type of product. The primary benefit in this application is increased quality, speed and consistency of the final product.

10. Other Processes
These include inspection, waterjet cutting and soldering robots.

Five Main Types of Industrial Robots

There are more than five types of industrial robots, but the most common ones can be (and should be) classified by their mechanical structure, according to the International Federation of Robotics.

Cartesian Robots
These work on three linear axes using the Cartesian Coordinate system (X, Y and Z), meaning they use three sliding joints to move up and down, in and out and side to side. The cartesian robot is the most commonly used industrial robot, typically for CNC machines or 3D printing.

SCARA Robots
Selective Compliance Articulated Robot Arm (SCARA) robots have two parallel rotary joints that provide compliance in a plane. The SCARA robot is commonly used for assembly applications and specializes in lateral movements.

Articulated Robot
With anywhere from two to 10 (or more) joints, articulated robots are connected to the base with a twisting joint. Resembling a human arm, they are commonly used in packaging, painting, metal casting and other industrial applications.

Delta Robots
Heavily used for manufacturing in the food, pharmaceutical and electronic industries, these spider-like robots are connected with a common base. The delta robot is typically used for fast pick and place applications due its precision at high speed.

Cylindrical Robots
Considered a good fit for tight spaces, this compact robot features at least one rotary joint for rotational movement and a prismatic joint for linear motion. Common cylindrical robot applications include simple assembly, die-casting and machine loading and unloading.